NUCLEAR PHYSICS

Synchrotron Makes Mesons

This powerful new atom-smasher has produced cosmic ray particles by radiation. First direct evidence that this can be done.

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➤ CREATION of the mysterious cosmic ray particles called mesons from the world's most powerful X-ray beam was reported to the American Physical Society in California by Dr. Edwin McMillan of the University of California Radiation Laboratory.

Dr. McMillan said that the cosmic ray particles had been made in the laboratory with the 300,000,000 electron-volt synchrotron.

Production of mesons by radiation in the synchrotron is believed to be the first direct evidence that these potent particles can be made from electro-magnetic radiation. Light, heat, electricity and radio waves are forms of electro-magnetic radiation. Another is the X-ray beam of the synchrotron.

The synchrotron, invented by Dr. McMillan, uses electrons, negatively charged electric particles, to bombard a heavy metal target. This creates the powerful, highly-penetrating X-ray beam.

The atom-smasher is three times as powerful as its cousin, the betatron, another type of electron accelerator; and several times as powerful as three smaller operating synchrotrons, two in England and one in the United States, which have a capacity of 70,000,000 electron volts or less.

Finer Atom-Smashing Tool

The synchrotron is a finer atom-smashing tool than the giant cyclotrons. The fine radiations it produces are expected to duplicate many of the phenomena observed in bombardments with the heavy nuclear projectiles—protons, deuterons and alpha particles—of the cyclotrons.

In addition, the synchrotron may produce cosmic ray showers similar to those found in nature, and may be the means for determining if neutrons and protons are divisible.

Vibrations caused as 160 kilowatts is thrown into and drawn out of the 135-ton electro-magnet cause parts of the machine literally to shake. The concrete foundation vibrates, in spite of the rubber pads on which the machine is mounted, and the synchrotron almost appears to be dancing a jig.

A loud noise accompanies operation. As the machine is turned on, a low thumping is heard, and this builds up to a loud, regularly spaced hammering as the magnet reaches full power, a noise akin to a high-powered diesel engine. Observers have remarked that this is an atom-smasher in which the atoms can be heard to crack.

The synchrotron is based upon the concept of phase stability which during the postwar period has revolutionized atom-smashing and upon which are based the billion-volt machines now on the drawing boards.

This concept is the theory of phase stability, originated independently by Dr. McMillan and the Russian scientist, Veksler, in 1945. This theory circumvents the Einstein relativity principle which had apparently put a ceiling on the energies to which particles could be accelerated.

Theory of Relativity

Relativity states that as a particle gains energy it gains mass; and while the particle, when it becomes heavier, can still be accelerated, this can be done only at a slower rate. In prewar atom-smashers this meant that as projectiles reached higher energy they would lag and fall out of step with regularly timed pushes of prewar atom-smashers.

The synchrotron gets around this in a unique way. As the electrons reach higher and higher energy, the power of the field of the magnet is increased proportionately. The result is that the laggard electrons are jerked up to the acceleration point in time to be propelled to higher energy.

Electrons are accelerated in a doughnut-shaped quartz chamber, two meters in diameter, which is placed between the ring-shaped poles of the electro-magnet. The quartz chamber is silver plated, except for a short section, a gap at which point the particles are propelled.

When electrons are injected into the chamber, they are first hustled around the orbit by the sheer force of the magnet acting on the particles. Up to 2,000,000 electron volts, the machine thus operates as a betatron.

At 2,000,000 electron volts, high frequency power is poured on the silver plating of the chamber, making it a resonant cavity. Operation is timed so that as the electrons reach the gap in the cavity, the far side of the gap is positively charged. This attracts the electrons violently across the gap, speeding them up. By the time the electrons go around the circle again, the current has gone through a complete cycle, and the electrons receive another push. The oscillator providing the accelerating current is capable of reversing the alternating power 48,000,000 times a second.

The magnet guides the particles around the orbit.

The synchrotron goes through a full operation six times each second. For each operation, lasting for a period of one-thirtieth of a second, a "flight" of electrons is accelerated to full energy. Each "flight" tours the chamber 480,000 times before it reaches 300,000,000 electron volts. By the time an electron reaches that energy, it weighs 600 times what it did at rest.

When a flight of electrons reaches peak energy, the oscillator is turned off. The electrons, no longer receiving accelerating impulses, spiral inward, strike a heavy metal target, and liberate X-rays.

Power Stored in Condenser

Power for the synchrotron magnet is stored in the largest condenser bank in the world, which acts like a storage tank as shown on the cover of this week's SCIENCE NEWS LETTER. The "tank," consisting of 3,328 condensers and storing 100,000 joules, is kept full by an ordinary power line.

During the one-thirtieth second operations, this tremendous power is switched into the magnet and back into storage again by four ignitrons. The power loss is small, and this makes for economy.

The magnet has a field strength of 10,000 gauss, stands 98 inches high, 194 inches long, and 92 inches in breadth.

Dr. McMillan's chief associate in construction of the machine was Marvin Martin, engineer in the Radiation Laboratory.

TINY TUBES FORM CLAY—This tubular structure of a common red clay called halloysite was discovered by studies with an electron microscope, which magnified the clay up to 60,000 times. This picture of halloysite and other clays was made at Pennsylvania State College by Thomas F. Bates, Fred A. Hildebrand and Ada Swineford.